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EARNINGS LOSSES OF WORKERS DISPLACED FROM MANUFACTURING INDUSTR--ETC(U)

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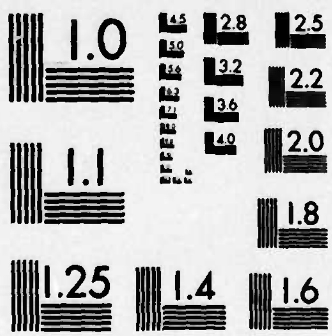
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Earnings Losses of Workers Displaced From Manufacturing Industries

Louis S. Jacobson

PUBLIC RESEARCH INSTITUTE
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EARNINGS LOSSES OF WORKERS DISPLACED FROM MANUFACTURING INDUSTRIES

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Louis S. Jacobson

Professional Paper 169

11 November 1976

12 35p.

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Presented at a conference sponsored by the Bureau of International Labor Affairs, U.S. Department of Labor on "Impact of International Trade and Investment on Employment" held on 2 and 3 December 1976.

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INTRODUCTION

A particularly sensitive current policy issue is the effect of changes in tariffs and quotas on employment and earnings. This study examines empirically some of the effects of a permanent labor displacement which might result from changes in international trade policy. Specifically, it ~~this paper~~ presents estimates of how job displacement would change the long-term earnings of workers in 11 ~~eleven~~ industries, and relates the findings to industry characteristics so that they can be projected to industries not directly studied. This study ~~The study described here~~ was designed to assist in determining industries in which trade liberalization would impose large losses on workers.

~~The~~ Results show that average prime age male workers suffer substantial losses of earnings in industries where the normal rate of labor turnover is low and prime age males make up a high percentage of the total labor force. These industries also tend to be high wage industries.

Displacement from the auto and steel industries is estimated to reduce earnings over a 6 ~~six~~ year period by about 24% ~~percent,~~ and by almost as much in several other high wage industries. The estimated loss in low wage industries was ~~very~~ much smaller, averaging about 5%; in some cases, such as cotton weaving, no appreciable loss could be detected.

The methodology and data used in the study were applied earlier in measuring how the earnings of steel workers would change if they lost their jobs due to import competition.* That study used data drawn from the Social Security System's Longitudinal Employee-Employer Data (LEED) file to examine both earnings losses per worker and the number and characteristics of workers displaced under a range of circumstances, for groups of workers who differ by race, age, and prior work history. We found that the earnings losses for most groups of steel workers would

*Louis Jacobson, "Earning Losses of Workers Displaced from the Steel Industry by Imports of Steel," Public Research Institute (PRI) 197-75, August 1975.

be quite large, totaling as much as $17,000 over a given worker's lifetime. We found that although any worker losing his job would pay a high price, comparatively few workers would be placed in this position as a result of trade liberalization.

This study extends our earlier work to other industries, providing estimates of how much the earnings of displaced workers would be reduced.* The basic procedure used was to measure the earnings of workers after they permanently left an industry during an employment reduction. These earnings are then compared to the earnings of similar workers who were not displaced during the employment cutback.

Although we are interested in losses resulting from an employment reduction induced by trade liberalization, the employment reductions we examined were due, in most cases, to other causes. The size of the loss depends on the value of human capital lost and on the costs of searching for a new job, not on the reason an employment reduction is made, however. The findings are thus relevant for considering how reduced labor demand affects a worker's earnings, whether the reduced demand is due to import penetration or to other factors such as changes in technology or government regulations like pollution control.

DEFINITIONS

In the discussion which follows, a number of terms with precise meanings are used repeatedly.

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*The steel study was more complete in examining earnings losses. That study measured how losses were affected by workers' age and tenure, and by economic conditions in the workers' local labor market. It also handled the basic data somewhat differently. Workers were grouped based on changes in steel employment by plant rather than by standard Metropolitan Statistical Area (SMSA) and separations in different years were examined. Nevertheless, the results from the steel industry when redone using the methodology described in this paper were strikingly similar; thus, enhancing our confidence in the results presented here.

The objective of the study is to measure the effects of reductions in labor demand on the earnings of workers in industries likely to be affected by increasing import penetration. Earnings loss is the difference between what a worker actually earns after demand has fallen and what he would have earned had demand not fallen at that time.

To measure earnings losses, we compare the earnings of workers who are adversely affected to the earnings of workers who are not affected. A basic distinction is between workers who permanently left an industry in a year when labor demand was falling and those who did not leave in that year. Workers who left are called leavers; those who did not leave are called stayers.

Some leavers would have left because of illness, discharge for cause, or to search for a better job, even if there had been no employment reductions. Such leavers are called attritions. Workers who leave an industry permanently and would not have done so in the absence of reductions in labor demand will be called displaced workers.* These displaced workers are the principal focus of the study.

To measure the earnings losses of displaced workers, we should compare their post-displacement earnings to the earnings of similar workers who were not displaced. The data did not allow us to distinguish which were attritions however. Instead, losses of displaced workers were estimated by measuring how earning changes differed in groups of leavers that contained different proportions of displacements and attritions.

We were able to identify two groups of workers who permanently left each industry. One group included most of those displaced but also included some

*The displacement and attrition concepts used in this paper are not analogous to the more usual BLS turnover concept of layoffs and quits. As measured by BLS, all but about 15% of layoffs do not lead to a permanent separation. We can not even consider all permanent layoffs as displacements since some of these workers would have left anyway and should be considered attritions. Similarly, quits measured by BLS exclude workers who leave due to accident, illness, or discharge. This probably accounts for at least one-third of attritions.

attritions. The other comprised mostly attritions but included some displaced workers as well.

By assuming that otherwise similar attritions in both groups had the same earnings, and that otherwise similar displaced workers in both groups had the same earnings, and by estimating the probability that a worker would be classified as an attrition, we could then subtract out the effect of attrition on the earnings of the group containing most of the displaced workers; the remainder would then be a measure of the earnings loss due to displacement alone.

The two groups were identified by dividing workers in each industry on the basis of whether employment in the industry in the worker's SMSA was rising or falling in the year of separation. An SMSA with rising industry employment will be called a rising SMSA. An SMSA with falling industry employment will be called a falling SMSA. Thus, the group of leavers in SMSAs where employment was increasing (rise-leavers) were less likely to be displaced workers than the group of leavers in SMSAs where in the aggregate firms are reducing employment (fall-leavers).

The measured loss in earnings for rise-leavers proved to be a reasonably accurate estimate of the loss due to displacement alone. Losses estimated by subtracting out the effect of attrition from the weighted average of losses did not add much useful information because they were subject to a very large measurement error. They did, however, suggest that using the loss estimates for the group with comparatively more displacements, without correcting for the inclusion of attritions, tended to slightly underestimate the loss due to displacements alone in high wage industries, to overestimate the loss in lower wage industry, and to accurately estimate the loss in industries in the middle of the earnings distribution.

The following discussion will describe in greater detail how these results were obtained. This will be followed by a discussion of possible underlying determinants of these results.

MEASURING EARNINGS LOSSES

In order to measure what the earnings of workers who recently separated from a given industry would have been had they not left, a comparison group of stayers in the same industry is statistically matched to the leavers so that earnings potential is distributed identically between the two groups. Then the earnings of these two groups are compared over time.

Although many previous studies have examined the earnings losses of workers, few, if any, use a comparison group.* Mostly, the measures of earnings losses are based on before-and-after comparisons among those losing their jobs. This procedure may be acceptable in industries where age-earnings profiles are flat and specific human capital is not important, but it can lead to very misleading results. In the industries studied here, a before-and after comparison among leavers would underestimate the total loss since earnings of very few of these workers are reduced below pre-separation earnings for more than a year or two.

Also, because a before-and-after comparison generally shows only a short-lived effect, it is not possible to estimate the permanence of the loss and the nature of the recovery process.

The methodology for measuring the loss econometrically was derived from our previous work on the steel industry and recent attempts to measure the impact of manpower training on earnings. The analysis is based on simple autoregressive model of earnings determination, sometimes called an earnings generating function. Equation 1 shows one specification for this function designed to be applied separately for different race-sex groups.

$$(1) \qquad Y_t = a_t + \sum_{i=1}^{k} b_{it} Y_{t-i} + c_t D \qquad t=0, 1, \ldots, 5$$

*Holen, Arlene, "Losses to Workers Displaced by Plant Closure or Layoff: A Survey of the Literature," 21 July 1976, (PRI)257-76.

where

Y_t = earnings year t

D = a dummy variable equal to one if an individual was displaced in year 0, equal to zero otherwise.

Figure 1 illustrates the comparison being made using the autoregressive earnings function. The solid line represents the actual earnings of workers displaced in year zero. The dashed line represents the earnings of workers whose prior earnings patterns were identical but who were not displaced in year zero. The vertical difference between the two lines represents the earnings loss due to displacement.

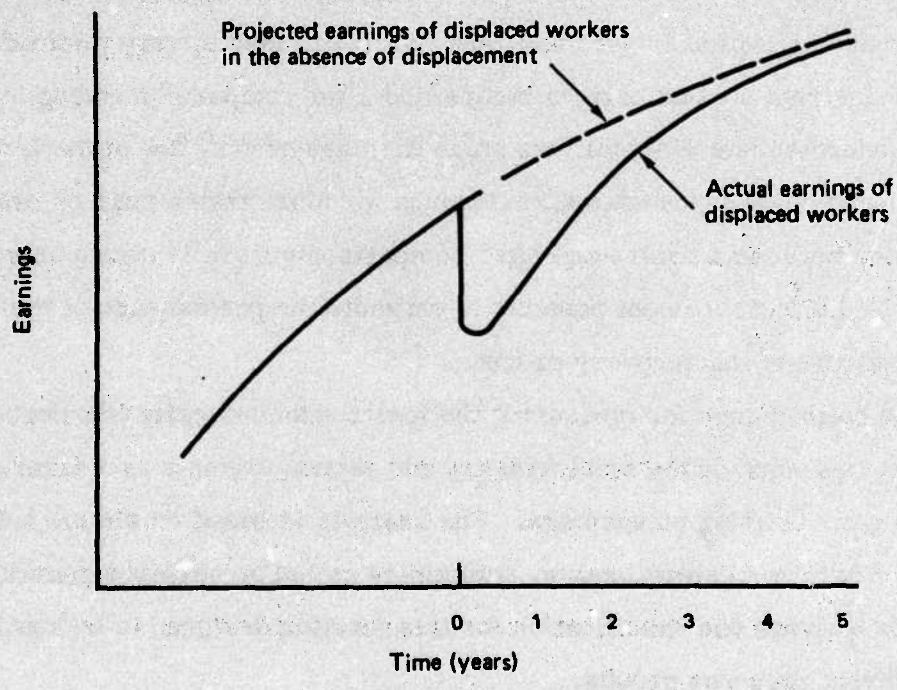

FIG. 1: COMPARISON OF EARNINGS OF DISPLACED WORKERS AND WORKERS NOT DISPLACED

The two curves also illustrate how a loss measure based on a before-and-after comparison can lead to systematic underestimates of the actual loss. The aggregate loss, measured relative to a comparison group, is equal to the area between the two curves. The earnings loss based on a before-after comparison is only the

area bounded by a horizontal line drawn through the earning level just before the start of year zero and the line describing the actual earnings of displaced workers.

Although studies of manpower training frequently recognize the importance of using an appropriate comparison group in measuring earnings differences, this particular formulation has only been developed recently for use with Social Security earnings data similar to the Social Security data used here. It is more common to use variables such as age, education, occupation, and marital status to control for differences in earnings potential. Sherwin Rosen and others have argued, however, that "previous earnings patterns must be among the most powerful controls for reckoning earnings capacity, being the end result of the (human capital) accumulation process itself.* Orley Ashenfelter has shown, in a recent paper*, that the functional form is fully consistent with what is known about the shape of the age-income profile and that under reasonable assumptions, the formulation is also consistent with a Becker-Mincer type model of optimal human capital accumulation.

Most importantly, this approach produces what are generally regarded as the most accurate estimates of the impact of manpower training available to date. In particular, by comparing earnings trajectories prior to entering a manpower training program, Ashenfelter demonstrates that this methodology is accurate in statistically matching a trainee and comparison groups in the pretraining period, even though the samples are drawn from very different populations. His comparison group included a random sample of all workers covered by Social Security.

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*Rosen, Sherwin, "Human Capital: A Survey of Empirical Research," University of Rochester, Department of Economics, Discussion paper, January 1976, mimeo, p. 37.

*Ashenfelter, Orley, "Estimating the Effect of Training Programs on Earnings with Longitudinal Data," paper presented at the Conference of Evaluating Manpower Training Programs, 7 May 1976, Industrial Relation Section, Princeton University.

In this work, the comparison group for workers displaced from a given industry is selected from other workers in the same industry. Additional information about the age and job tenure of workers is used to control for differences between the groups of separatees and comparison groups of stayers. The estimated earnings differences should, therefore, be considerably more accurate.

Modification of the basic autoregressive earnings function (equation 1) is required because, as discussed earlier, there is no simple way of determining whether a worker who separates from an industry is displaced or leaves due to normal attrition. Even if it was known which workers were laid off, it would not be correct to assume that all such workers were displaced. Many workers with a high probability of being laid off would have left anyway in the absence of layoff.

For instance, recently hired young workers are very likely to change jobs in any event. These workers, however, are precisely those most likely to be laid off when employment must be reduced.

Because subsequent earning trends of displaced workers may be considerably different than the earning trends of workers leaving due to attrition, it is essential to determine how our results are affected by this potentially complicating factor.

To identify losses due to displacement from a given industry, the sample of workers employed in the industry in year zero was divided on the basis of whether employment in the worker's industry was rising or falling in the worker's SMSA in the year of separation.

This produced four groups.

FALL-LEAVERS - those who separated from the industry in a year when industry employment in the SMSA was falling.

RISE-LEAVERS - those who separated in a year when industry employment in the SMSA was rising or unchanged

FALL-STAYERS - those who remained in the industry when industry employment in the SMSA was falling

RISE-STAYERS - those who remained in the industry when industry employment in the SMSA was rising or unchanged

The earnings of fall-leavers and rise-leavers following separation represent different combinations of the earnings of workers who left due to both attrition and displacement, as shown in figure 2. Equations 2a and 2b show the distinction more explicitly:

(2a) $Y_{FL} = \alpha Y_A + (1-\alpha) Y_D$

(2b) $Y_{RL} = \beta Y_A + (1-\beta) Y_D$

where

Y_{FL} = average annual earnings of fall-leavers in any year following separation

Y_{RL} = average annual earnings of rise-leavers in any year following separation

Y_A = average annual earnings of workers leaving due to attrition in any year following separation

Y_D = average annual earnings of workers displaced in any year following separation

α = proportion of fall-leavers leaving due to attrition

β = proportion of rise-leavers leaving due to attrition

FIGURE 2

CLASSIFICATION OF WORKERS IN AN INDUSTRY

	INDUSTRY EMPLOYMENT IN SMSA	
EMPLOYEE	FALLING	RISING
STAYS	FALL-STAYER	RISE-STAYER
LEAVES	FALL-LEAVER	RISE-LEAVER

COMPARATIVELY MORE DISPLACEMENTS

COMPARATIVELY MORE ATTRITIONS

We now make two crucial assumptions. First, we assume that, holding personal characteristics and workers' histories constant, a worker leaving a particular industry due to attrition will have the same earnings, irrespective of whether industry employment is rising or falling in the SMSA. Second, we assume the same condition holds for all displacement. Thus, as shown in equation 3, equations 2a and 2b can be solved simultaneously for Y_D in terms of α, β, Y_{FL}, and Y_{RL}.

(3) $$Y_D = \frac{\beta}{\beta-\alpha} Y_{FL} - \frac{\alpha}{\beta-\alpha} Y_{RL}$$

Since Y_{FL} and Y_{RL} are observable we need to estimate only α and β to determine the earnings of displaced workers. To do this, we make the assumption that, controlling for worker characteristics, the probability of leaving due to attrition is independent of whether employment in a particular industry is rising or falling in an SMSA.* The observed number of workers leaving an industry in rising SMSAs divided by the total number employed in the industry in rising SMSAs $(\frac{N_{RL}}{N_R})$ is a good measure of the probability of leaving. This fraction times β is an estimate of the probability of leaving due to attrition in both rising and falling SMSAs. α is the proportion of fall-leavers separating due to attrition. It equals by definition the probability of leaving due to attrition times the number of risers divided by the number of fall-leavers. This relation is shown in equation 4.

*This assumption is probably an oversimplification. To some extent, the age and tenure specific attrition probabilities will be affected by changes in the probability of finding a better job which will, in turn, be associated with cyclical swings. The effect may not be important here because the observations are cross sectional and the relative returns from job change may not vary much across SMSAs. In addition, there may be a systematic relation between changes in employment in an individual industry in an SMSA and changes in general business activity in the SMSA. This would tend to equalize relative returns of leaving a specific industry in falling and rising SMSAs. There is little empirical evidence bearing on the accuracy of the assumption. In particular, the cyclical sensitivity of the BLS quit rate may be due to changes in the age and tenure distribution of those employed rather than changes in the age and tenure specific quit propensities.

(4) $\alpha = \beta \cdot \gamma$

where

$$\gamma = \frac{N_{RL}}{N_R} \cdot \frac{N_F}{N_{FL}}$$

Substituting equation 4 into equation 3 produces an expression for the earnings of displaced workers, Y_D, in terms of Y_{FL}, Y_{RL}, and γ, all of which can be estimated empirically. This expression is shown in equation 5.

(5) $$Y_D = \frac{1}{1-\gamma} Y_{FL} - \frac{\gamma}{1-\gamma} Y_{RL}$$

Finally, we can transform equation 5, expressing Y_D as a function of Y_{FL} alone plus an <u>adjustment factor</u>. This is done by subtracting $\frac{\gamma}{1-\gamma} Y_{FL}$ from the first right hand term and adding it to the second right hand term of equation 5. The transformed equation is shown in equation 6.

(6) $$Y_D = Y_{FL} + \frac{\gamma}{1-\gamma} (Y_{FL} - Y_{RL})$$

The earnings of fall-leavers would provide an adequate point estimate of the earnings of displaced workers if either γ was very small or the difference in the earnings of fall-leavers and rise-leavers was small. In both instances the adjustment factor shown in equation 6 would be extremely small.

Measuring the <u>earnings</u> of displaced workers is an intermediate step. What we want to measure ultimately is the earnings <u>loss</u> of displaced workers. To do this we must subtract the earnings of a comparison group of workers not displaced from the earnings of displaced workers.

Either fall-stayers or rise-stayers could have been used as a comparison group. It turned out that the earnings of workers in both groups were very similar; the earnings of fall-stayers were slightly below those of rise-stayers in the year separation occurred. Probably this is because fall-stayers are more likely to be on short hours or temporarily laid off in that year. Fall-stayers were chosen as the comparison group based on the supposition that displacements due to trade

liberalization are likely to be large only when an industry is depressed anyway. The stayers in a trade impacted industry would therefore probably be more like the fall-stayers than the rise-stayers.

To calculate the losses (L_D) of displaced workers, the earnings of fall-stayers were subtracted from both sides of equation 6. This produced equation 7:

(7) $$L_D = L_{FL} + \frac{\gamma}{1-\gamma} (L_{FL} - L_{RL})$$

where

$$L_i = -(Y_i - Y_{FS}) \qquad i = D,\ FL,\ RL$$

Equation 8 was used in the econometric estimation of earnings losses.*

(8) $$\begin{aligned} \text{EARNINGS-t} = {} & a_0 + a_1\text{EARNINGS-M1} + a_2\text{EARNINGS-M2} + a_3\text{EARNINGS-M3} \\ & + a_4\text{AGE} + a_5\text{TENURE} + a_6\text{RACE} + b_1\text{Y63} + b_2\text{Y64} + b_3\text{Y65} \\ & + c_1\text{FALL-LEAVE} + c_2\text{RISE-LEAVE} + c_3\text{FALL-STAY} \\ & + (d_1\text{QSEP2} + d_2\text{QSEP} + d_3\text{QSEP4}) \end{aligned}$$

$t=0, 1, \dots, 5$

where

EARNINGS-i = Average Quarterly Earnings in year i (year i=0 is year some workers left year i=M1 is one year before displacement)

AGE = Age in years as of year = 0

TENURE = Tenure since 1957 in quarters as of year = 0

RACE = Race dummy 0 = white, 1 = non-white

Y_i = Dummy variables for actual year some workers left (Samples for four years are pooled. Y62 is omitted.)

*A slightly different estimating equation was also used. This equation crossed age and tenure dummies with the fall-rise, stay-leave dummies in order to measure how earnings losses differed by age and tenure as well as by industry. The small sample size of many age-tenure groups, however, made accurate measurement difficult. The primary value of these regressions was that they showed differences in the average losses across industries were not due to differences in the age and tenure distribution of the industries' work forces.

FALL-STAY RISE-LEAVE FALL-LEAVE	=	Dummies for four subsamples - workers either leave in year = 0 or stay in year = 0, and are either employed in SMSAs where industry employment fell or did not fall in year = 0 (RISE-STAY is omitted).
QSEPI	=	Quarter of Separation in year = 0, dummies. (QSEP1 is omitted) (These variables are enclosed in parentheses because regressions were run both with and without these variables.)

The first four terms in the equation incorporate the auto-regressive earnings generating function shown in equation 1. These variables, together with age and tenure, control for differences in human capital. The race variable is included to take into account the possibility that the earnings generating function is different for blacks and whites. In part this difference may be a result of discrimination.

The year dummies are required because leavers and stayers in four separate years, 1962-64, were pooled in the regression. The pooling was done to increase the sample size and thereby improve the statistical accuracy of the results. There was considerable variation over time in industry employment within each SMSA. That is, a falling SMSA in one year had an equal probability of being a rising SMSA the next. This limited the possibility that SMSA-specific characteristics rather than differences due to attrition and displacement were responsible for differences in earnings of fall-leavers and rise leavers.

The 1962-65 period was chosen because a substantial period was needed in order to trace the earnings pattern following displacement. The year dummies thus control for systematic differences in earnings from 1962-65 due to either changes in productivity or the inflation rate over time. The quarter-of-separation dummies adjust the losses to reflect separation at the beginning of a calendar year. This is particularly important in the year of separation.

The c_1, c_2 and c_3 coefficients measure the earnings difference between fall-leavers, rise-leavers, and fall-stayers respectively and rise-stayers $(Y_i - Y_{RS})$. Equation 7 can be expressed in terms of these coefficients as shown in equation 9 below:

$$L_D = -[c_1 - c_3 + \frac{\gamma}{1-\gamma}(c_1 - c_2)] \quad (9)$$

INDUSTRY AND WORKER SELECTION

The methodology described in the previous section was used to estimate the earnings losses of displaced workers shown in figure 1. The industries are listed in order by average earnings of workers before leaving. They were chosen to represent a diverse group of manufacturing industries. The wide range for each industry characteristic included in table 1 indicates that this effort was reasonably successful. Selection also required that the industries have: (a) a wide geographic distribution to improve the dispersion of employment changes across local labor markets and thus increase the accuracy of the fall-rise breakdown; (b) large declines in employment, to produce as large a sample of fall-leavers as possible; (c) substantial import competition.

TABLE 1

WORKER CHARACTERISTICS BY INDUSTRY

Industries studied	Average earnings of prime-age male leavers (in 1964 dollars)	Prime age (23-53) males as a percent of total employment	Prime-age male attrition
1. Petroleum refining	7677	66	1.8
2. Aerospace	7132	68	4.2
3. Electronic components	6338	33	4.5
4. Television receivers	5874	36	10.6
5. Steel	5712	72	1.9
6. Automobiles	5688	71	1.6
7. Meat packing	5320	64	1.5
8. Toys	4670	34	11.9
9. Women's clothing	4670	10	5.8
10. Shoes	3824	26	9.6
11. Cotton weaving	3705	38	8.0

The size of the average loss was estimated for each of six years following displacement using equation 8 for all workers meeting the criteria shown in table 2. The first criterion limits the sample to workers who were permanently attached to

the industry before they were displaced. The second criterion insures that each worker can be classified as a riser or faller. The third criterion, including work histories of prime age males only, is designed to limit the study to workers least likely to withdraw from the labor force. Labor force withdrawal creates the very difficult problem of evaluating the monetary value of nonmarket time. The fourth criterion is related to the third: Once the group studied is limited to workers unlikely to withdraw from the labor force a year or more of no reported earnings most probably is associated with work in uncovered employment, which is primarily self-employment, agricultural, and government work, incapacitation due to accident or illness, or a reporting error of some type. If workers in these categories were included in the sample, it would lead to serious over-estimation of the earnings loss. The fact that some displaced workers who were included in the sample may work part-time in covered employment but full-time in uncovered employment means the losses may still be slightly overestimated.

TABLE 2

SELECTION CRITERIA

1. Employed at least three consecutive quarters in the designated industry and employed at least one quarter during the period 1962-65.
2. Employed in one of 229 SMSAs defined in 1967.
3. Males, age 23-53, in above year.
4. Reported earnings each year 1960-70.

Table 3 shows the size of the samples for each of the four subgroups in each industry, based on the criteria discussed above, and the estimated value of γ based on equation 6. We will call γ the probability of leaving the industry, in a falling SMSA, due to attrition. This is strictly true only if $\beta = 1$.

In all cases, the sample size of the stayer groups is large enough to ensure an accurate measure of their earnings, which is assumed to represent what leavers would have earned had they stayed. Among leavers, however, there are several cases where the samples are fairly small and estimation of losses probably is less

TABLE 3

SAMPLE SIZE FOR THE FOUR SUBGROUPS IN EACH INDUSTRY AND ESTIMATED PROBABILITY OF LEAVING DUE TO ATTRITION

	Oil	Aero-space	Elec.	TV recvrs.	Steel	Auto	Meat	Toys	Women's clothing	Shoes	Cotton
1. RISE-STAYERS (RS)	553	10,204	1094	573	5280	4068	2628	275	376	359	428
2. FALL-STAYERS (FS)	1693	5,306	632	131	5673	678	1104	229	568	387	338
3. RISE-LEAVERS (RL)											
a. number	10	451	51	68	105	66	41	38	23	38	37
b. % RL=RL/(RL+RS)	1.8	4.2	4.5	10.6	1.9	1.6	1.5	11.9	5.8	9.6	8.0
4. FALL-LEAVERS (FL)											
a. number	77	394	49	28	103	68	111	37	45	56	46
b. % FL=FL/(FL+FS)	4.4	6.9	7.2	17.6	1.8	9.1	9.1	13.9	7.3	12.6	9.4
5. Estimated probability of leaving a falling SMSA due to attrition (γ)	.41	.61	.63	.60	.45*	.18	.16	.86	.79	.76	.85

*The estimate of γ for the steel industry was derived from more highly disaggregated data than used to designate falling and rising SMSAs.

precise. It is somewhat surprising that the number of fall-leavers is not greater, particularly because a major criterion for including an industry in the study was that it had experienced substantial employment reductions. Even in shoe manufacturing, which is generally regarded as a prime example of a declining industry, only slightly more than 50% of the workers were in SMSAs with employment declines.

It also appears that in some cases such as toy manufacturing and cotton weaving, the reductions themselves are not severe in a single labor market but are widely dispersed. For these industries, the separation rate is only about 15% higher in SMSAs where industry employment fell than where it rose.

The results for the steel industry appear atypical. The proportion of workers in SMSAs with falling employment is higher than for other industries and the rate of leaving falling SMSAs lower. On close inspection it was discovered that the unusually heavy concentration of steel workers in Pittsburgh SMSA (one third of all steel workers) coupled with the fact that employment in Pittsburgh fell by very small amounts in three of the four years was responsible for these results. For instance, the employment reduction in 1962 was only about 1/2 of a percentage point. This raised the total number of workers in falling SMSAs and made the separation rate for fall-leavers appear unusually low.

The small observed employment reduction resulted from aggregating across the steel plants in Pittsburgh, some of which were increasing employment while others were decreasing employment. Fortunately, our previous work on the steel industry permitted us to disaggregate employment within SMSAs. The disaggregated data was used to estimate the value of γ for the steel industry shown in table 3.

ESTIMATED EARNINGS LOSSES

Table 4 shows the annual earnings loss, averaged over the first six years following displacement, for fall-leavers compared to fall-stayers and rise-leavers compared to fall-stayers. The cases where the loss is an earnings reduction is

TABLE 4

LOSS OF FALL-LEAVERS AND RISE-LEAVERS

	Oil	Aero-space	Elec.	TV recvrs.	Steel	Auto	Meat	Toys	Women's clothing	Shoes	Cotton
1. Average earnings loss for FALL-LEAVER relative to FALL-STAYER $L_{FL}=Y_{FL}-Y_{FS}=c_1-c_3$	955 (300)	1284 (151)	351 (472)	-269 (514)	1366 (226)	1380 (300)	1064 (299)	167 (467)	274 (631)	180 (359)	-191 (289)
2. Average earnings loss for RISE-LEAVER relative to FALL-STAYER $L_{RL}=Y_{RL}-Y_{FS}=c_1-c_2$	413 (713)	896 (144)	397 (474)	372 (383)	1521 (219)	1504 (323)	1300 (323)	-366 (471)	554 (747)	476 (393)	127 (274)

Note: Negative signs indicate earnings gains (negative losses).
Standard errors are shown in parentheses.
Dollar figures are in 1964 dollars.

indicated by an unsigned number. Negatives denote the few cases where the "loss" is actually an earnings increase. The standard error of the estimates over the six years are shown in parentheses.

The losses of the fall-leavers are substantial and significantly different from zero in five of the eleven industries -- oil, aerospace, steel, auto, and meat. As shown in table 1, these industries are among the higher wage industries and employ the highest percentages of prime age males.

In industries where rise-leavers suffer large losses, fall-leavers also tend to have large losses, and vice versa. The losses are substantial and statistically significant in four industries. The only industry where fall-leavers show a statistically significant loss but rise-leavers do not is oil. This is probably due to the very small sample of rise-leavers in the oil industry.

The fact that rise-leavers show losses in all but one industry is worth comment. It is likely that these workers are almost all attritions. Although attritions include some workers quitting to take a better job, the evidence suggests that this type of attrition is relatively rare and the predominant reason for leaving in the absence of a firm's desire to lower employment is a mismatch between a worker's tastes and abilities and what employees require to perform a job. This explanation is also supported by the finding that rise-leavers show larger losses than fall-leavers in eight of the eleven industries. Thus, workers who leave due to attrition are estimated to have <u>larger</u> losses than displaced workers.*

This evidence is consistent with the hypothesis that the quality (amount of human capital) of displaced workers is higher than the quality of those leaving due to attrition. If this is true, potential employers may usefully screen job applicants on the

*The fact that these results are for 1962-65, a period of relatively high unemployment, when comparatively few opportunities for job advancement were available, possibly accentuated the difference between rise and fall-leavers. It would be possible to test this finding by examining the difference over the business cycle.

basis of a previous history of strong job attachment and may reasonably prefer to hire workers who had been laid off rather than those who quit. This appears to be particularly true in low wage industries where minimal skills are required.

Losses Due to Displacement

We are finally in a position to calculate the loss due to displacement. As shown in equation 5 the loss is the sum of two terms. The first term is the estimated loss of fall-leavers and the second term, which we called an adjustment factor, is the product of two elements. The first is the differences between the loss of fall-leavers and rise-leavers, which for simplicity we will represent as ΔL. The second is an expression which is a function only of γ. The value of the expression by which ΔL will be multiplied is shown for each industry in the first line of table 5. The value of the expression has a very broad range, from .19 for the meat packing industry to 6.14 in toy manufacturing.

The difference between the losses at fall-leaver and rise-leaver (ΔL) are shown on line 2 of table 5. A positive number indicates that fall-leaver losses exceed those of rise-leavers, a negative number indicates the reverse. These figures are generally small and are not statistically significant.

Only in aerospace can we reject the hypothesis that fall-leavers and rise-leavers suffer the same losses. This finding is a reflection of the strong correlation between the losses of fall-leavers and rise-leavers in the same industry noted in discussing table 4.

On the other hand, differences from industry to industry exist and exhibit a distinct pattern. With only two major exceptions, TV and toys, the losses of rise-leavers become progressively larger relative to the fall-leaver losses as the average earnings of the industry's leavers falls.

The adjustment factors, which equal the products of the figures on lines 1 and 2, are presented on line 3. An estimate of the standard error of the adjustment factor, assuming that the value of γ is known with certainty, is shown in parentheses. In several instances the standard error is extremely large. In fact these

TABLE 5

DATA ELEMENTS USED TO CALCULATE DISPLACEMENT LOSS, LOSS DUE TO DISPLACEMENTS

	Oil	Aero-space	Elec.	TV recvrs.	Steel	Auto	Meat	Toys	Women's clothing	Shoes	Cotton
1. $\frac{\gamma}{1-\gamma}$	.69	1.56	1.70	1.50	.82	.22	.19	6.14	3.76	3.17	5.67
2. Difference in the loss of FALL-LEAVERS relative to RISE-LEAVERS (ΔL)	542	388	-46	-641	-155	-126	-218	533	-280	-296	-378
	(744)	(203)	(669)	(641)	(315)	(481)	(396)	(663)	(978)	(522)	(398)
3. Adjustment to the loss of FALL-LEAVERS to reflect displacement ($\frac{\gamma}{1-\gamma}\Delta L$)	377	607	-78	-737	-128	-27	-45	3274	-1053	-937	-1802
	(534)	(317)	(1137)	(962)	(258)	(106)	(75)	(4071)	(3677)	(1655)	(2257)
4. Displacement loss $[L_{FL}+\frac{\gamma}{1-\gamma}(\Delta L)]$	1332	1891	-273	-1006	1239	1353	1019	3441	-779	-757	-1993
	(613)	(351)	(1223)	(1090)	(343)	(318)	(241)	(4098)	(3731)	(1693)	(2275)

Negatives denote earnings gains.
Parentheses denote a measure of the standard error of estimates
Dollar figures are in 1964 dollars.

large standard errors may be considerably underestimated since the value of γ is not certain and relatively small changes in γ can create extremely large changes in the value of the figures in row 1.

Finally the loss of fall-leavers from line 1 of table 4 is added to the adjustment factor to complete the calculation of the loss due to displacement. These results and the standard error are shown on line 4 of table 5.

Sizeable losses are shown for six industries. These losses are statistically significant in five cases. In aerospace, steel, autos, and meat, the standard errors of the estimates are relatively small, indicating that we can be reasonably confident of the point estimates.

Somewhat surprisingly, displacement is estimated to lead to an earnings gain in five of the eleven industries. In none of these cases, however, do the results approach acceptable levels of statistical significance by which we could reasonably reject the hypothesis that there are neither gains nor losses. It is disappointing that the methodology which was expected to produce unbiased results does not lead to the most reliable estimates. In fact, the unadjusted estimate of the losses of fall-leavers seems to be far more reasonable as point estimates. This can be seen in table 6 where the loss estimates based on assuming the unadjusted losses of fall-leavers adequately reflect the losses due to displacement, and the loss estimates using the indirect procedure, are shown in percentage terms.

For the five industries that show losses greater than 10%, the results using either procedure are relatively close. The correction for attrition, therefore, makes little difference. For the other industries, except electronics, the correction for attritions is so large as to be implausible. It is not difficult to see that the apparent overcorrection could easily be a result of even small measurement errors at high γs and the large variances surrounding the estimate of ΔL. The four figures in table 6 marked by asterisks are all cases where $\gamma > .75$ and standard error of ΔL is greater than 1600 or 43 percent of the average earnings figure.

EARNINGS LOSSES OVER TIME

The estimates of the earnings loss over the six years following job loss is a convenient summary of the relative displacement costs to workers in different industries. It is, however, an imperfect measure because year to year

differences are concealed. As can be seen in table 7, the losses of fall-leavers in the first two years following displacement is substantial in almost all industries. The information in table 7 also shows that the loss falls substantially in the subsequent four years.

TABLE 6

PERCENTAGE LOSSES OF FALL-LEAVERS AND DISPLACED WORKERS

	Unadjusted % loss of fall-leavers	Adjusted % loss of fall-leaver to reflect displacement
1. Auto	24.3	23.8
2. Steel	23.9	21.7
3. Meat	20.0	19.1
4. Aerospace	18.0	26.5
5. Oil	12.4	17.3
6. Women's clothing	5.9	-16.7 *
7. Electronics	5.5	4.3
8. Shoes	4.7	-20.0 *
9. Toys	3.6	73.7*
10. TV receivers	-4.6	-17.1
11. Cotton	-5.5	-54.0 *

*Indicates industries where $\gamma > .75$ and the standard error of ΔL is greater than 1600.

For the five industries where the loss remains substantial, there are important differences in the pattern in the latter period.

In autos and steel, the losses were extremely large, initially, but continually narrowed and apparently were eliminated by end of the sixth year. In the three other industries where initial losses were large, meat, aerospace and oil, the loss remained constant in years three through six. Losses in electronics were also constant

TABLE 7

EARNING LOSSES OF FALL-LEAVERS OVER TIME

Industries studied	Average percentage loss first 2 years	Average percentage loss subsequent 4 years
1. Automobiles	43.4*	15.8*
2. Steel	46.6*	12.6*
3. Meat packing	23.9*	18.1*
4. Aerospace	23.6*	14.8*
5. Petroleum refining	12.4*	12.5*
6. Women's clothing	13.3	2.1
7. Electronic components	8.3	4.1
8. Shoes	11.3	1.5
9. Toys	16.1*	-2.7
10. Television receivers	0.7	-7.2
11. Cotton weaving	7.4	-11.5

*Denotes loss estimate is statistically significant at the 5% level.
Negative indicates gains.

through those years, but the initial loss was small.* Apparently there is a permanent earnings reduction for workers in these industries. This means that the total discounted value of the loss is larger in these industries and smaller in the steel and auto industry than the undiscounted average loss figures suggest.

GENERALIZING THE LOSS PATTERNS ACROSS INDUSTRIES

A key objective of this study was to uncover systematic relationships between industry characteristics and the size of the earnings losses. Successfully identifying these relationships is important for two reasons:

- It will enhance our confidence that the losses are accurately measured for the industries studied,
- It will provide a means for projecting the losses in other industries.

Systematic relationships between industry characteristics and the measured losses of fall-leavers were analyzed. This was done rather than examining the displacement loss measured using the more complex method because, as just discussed. the adjustment may be a good indicator of direction but it probably overstates the magnitude of the bias.

Since it is possible that the losses are simply proportional to the earnings of displaced workers, the fall-leaver losses are examined in percentage terms to distinguish more sharply the reasons why losses differ across industries.

Patterns in the Losses of Fall-Leavers

The relationship between industry characteristics and losses for each of the eleven industries studied was examined using simple correlations and in a series of regressions. Losses of fall-leavers were calculated as a percent of the earnings of leavers prior to separation (% LOSS).

Industry characteristics included:

- The industry's attrition rate (ATTRITION) which was measured as the separation rate of prime-age workers in rising SMSAs.

*The earnings patterns for workers in all other industries became indistinguishable from the earnings path of workers who did not leave their jobs in year 0.

- The ratio of prime-age males to total industry employment (PRIMALE), derived from tabulations of LEED data.
- The average earnings of all leavers prior to separation (EARNINGS) which is a proxy for the average skill level of the industry.

The simple correlation among the percent loss and other variables is shown in table 8. A positive correlation means that a "loss" which is always represented here as a positive number becomes larger (more positive) as the other variable increases.

TABLE 8

CORRELATIONS AMONG PERCENTAGE LOSS OF FALL-LEAVERS ATTRITION RATE, PRIME AGE MALES PERCENTAGE AND AVERAGE EARNINGS

	% LOSS	ATTRITION	PRIMALE	EARNINGS
% LOSS	1.000			
ATTRITION	-.821	1.000		
PRIMALE	.774	-.760	1.000	
EARNINGS	.435	-.550	.598	1.000

For instance, the negative correlation between % LOSS and ATTRITION (-.821) indicates that the loss becomes smaller as the industry's attrition rate rises. The positive correlation between % LOSS and PRIMALE (.774) indicates that the loss becomes larger as the persent of prime age males rises.

Both these relations are in the expected direction, based on human capital theory. Industries with high normal turnover (attrition) are likely to offer jobs where specific training is not important. Thus, workers who leave those industries should not experience large permanent earnings losses. Industries where attrition is low probably offer jobs where specific human capital is very important, and leaving these industries should lead to large earning losses. The explanation for the strong correlation between the % LOSS and PRIMALE variables possibly can be based on the same argument concerning the degree of specific training in different industries. The prime age male variable could be a proxy for the proportion of production workers.

The supposition is that a far higher percentage of total human capital is industry specific for production workers than for workers in other occupations.*

Additional evidence that a loss of specific human capital is responsible for the size of the earnings loss comes from the finding that the EARNINGS variable is not significant and contributes very little to the explanatory power of the regression when either the ATTRITION or PRIMALE variables are included. One could argue that it is not specific human capital but simply that workers with high earnings experience larger losses. These workers have fewer "better" job opportunities and thus will have more trouble regaining their previous earnings level. This alternative hypothesis is not supported by the regression results.

The "best" regressions are shown in table 9 below. Because only eleven observations are included in the data and there is a high degree of intercorrelation among the explanatory variables, the highest adjusted R^2 occurred with both ATTRITION and PRIMALE entered together, although neither coefficient was statistically significant at the 95% confidence level. Almost as good a fit was obtained with PRIMALE alone. ATTRITION alone did slightly worse, with respect to both the standard error and R^2, than PRIMALE alone.

In all cases, the regressions were weighted by the inverse of the standard error of the measure of the fall-leaver losses. This was required to correct for the fact that the measurement errors on the independent variables, which were the results of separate regressions, were not equal as required for minimum variance Ordinary-Least-Square regression. The correction procedure is similar to that used in correcting for heteroskedasticity.

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*Note that all workers studied are prime age males. This argument is that in manufacturing industries most workers are production workers; thus in industries primarily employing prime age male workers a high proportion would be production workers. In industries with comparatively few prime age males, however, most of the production workers must be women or young men; thus the prime age males are more likely to be in supervisory, managerial, technical-scientific, or similar occupations.

The regressions with PRIMALE as an independent variable are particularly useful for projecting the losses of fall-leavers in industries other than those directly studied because the variable can be easily derived from tabulations already compiled from the LEED file or from standard sources. The ATTRITION regressions are less useful because the variable was based on turnover of prime age males in areas without heavy overall employment declines, a statistic not currently tabulated from the LEED file and not readily available from other sources. The quit rate in manufacturing in these industries is likely to be of some use in projecting losses but not nearly as good a measure as ATTRITION because the quit rate refers to workers in all sex-age categories. In industries with few prime age males, the quit rate will, of course, reflect turnover of these other groups.

TABLE 9

REGRESSIONS WITH PERCENT LOSS OF FALL-LEAVERS AS DEPENDENT VARIABLE

1. $\% \text{ LOSS} = \underset{(.3)}{4.03} - \underset{(1.4)}{.13} \times \text{ATTRITION} + \underset{(1.7)}{.27} \times \text{PRIMALE}$

   Adj R^2 = .86 F(2/8) = 30.5

2. $\% \text{ LOSS} = \underset{(2.0)}{-12.00} + \underset{(4.7)}{.46} \times \text{PRIMALE}$

   Adj R^2 = .84 F(1.9) = 54.2

3. $\% \text{ LOSS} = \underset{(8.5)}{25.6} - \underset{(4.4)}{.26} \times \text{ATTRITION}$

   Adj R^2 = .83 F(1.9) = 48.4

Variable description

% LOSS = Percent loss of fall-leavers relative to fall-stayers.
ATTRITION = Attrition rate of prime age males.
PRIMALE = Percent of total industry employment which is prime-age males.

SUMMARY and CONCLUSIONS

The major finding of this study is that earning losses are likely to be substantial for prime-age workers who are displaced from industries where the rate of attrition is very low and a high percentage of all employees are prime-age men. Earnings over a six-year period after displacement could be reduced as much as 25%. For a worker displaced in 1970, such a loss could total over $10,000. The losses are likely to be far less for workers displaced from industries where attrition is high and few prime age males are in the industry's labor force. Although our measurements for low loss industries are not nearly as accurate as for industries showing large losses, the losses probably would not average much more than 5% over a six-year period and could be considerably less.

Despite some measurement problems affecting estimates for individual industries, the results are intuitively appealing and make good economic sense. In particular, it is reasonable that workers forced to leave industries that normally offer relatively high wages and stable employment have difficulty finding an equally good job. The fact that low attrition industries also tend to offer high wages suggests that workers employed in these industries have special skills specific to the industry. This also suggests that these workers would have inordinate difficulty finding other employment where their skills can be used effectively.

A few caveats should be attached to these conclusions. First, this study was limited to measuring the earnings losses of prime-age males who returned to work following displacement. Workers of this type may not be in the majority in an actual displacement. Second, this study did not consider the impact on the losses of transfer payments other than severance pay. On the one hand, the loss of non-vested pensions might add considerably to the loss. On the other hand, if we had included unemployment compensation, the estimated loss would have been less. We estimate about half the loss is due to unemployment (rather than reduced wages). Finally the study did not consider nonpecuniary costs such as the psychic cost of adjusting

to unemployment, losing friends and familiar working conditions and adjusting to a new working environment.

Although it is theoretically possible that these factors would cancel each other, leaving our overall estimates unchanged, this is by no means certain. There is no reason to expect, however, that these factors would change the relative ranking of industries, in terms of the cost to workers displaced, which is probably the most useful information that we have uncovered for policy purposes.

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